Appendix B
Ice Jam Mitigation Case Studies

B-1. Kankakee River, Illinois—Thermal Control

a. The upstream end of the backwater from the Dresden Island Lock and Dam on the Illinois River extends to about River Mile 3.5 on the Kankakee River near Wilmington, Illinois. Frazil ice floes form a stable ice cover on the pool, which thickens as frazil ice then deposits beneath the ice cover. The thick frazil ice deposit requires more force to break up than the thinner upstream ice and provides an obstruction to the passage of upstream river ice, which breaks up prior to this thick ice deposit. An ice jam often forms at the upper end of the deposit and progresses upstream, flooding the city of Wilmington and surrounding areas. The ice jam flood in 1982, which caused more than $8 million in damages, was followed by other ice jam events in 1984 ($500,000) and 1985 ($1 million). Several alternative ice jam mitigation measures were considered. Because of the proximity of the cooling pond for the Dresden nuclear power plant, thermal ice control appeared feasible. The intent of the thermal control was to thin or melt the thick frazil deposits that resist breakup, thus allowing the fragmented ice from upstream to pass unobstructed.

b. In a demonstration project, 20°C (68°F) water from the cooling ponds adjacent to the Kankakee River near Wilmington was siphoned in three 0.76-m-diameter (30-inch-diameter) pipes into the river upstream of the ice cover for 2 weeks prior to the anticipated breakup in 1988 (Figure B-1). The maximum siphon flow is 4.25 m^3/s (150 ft^3/s) compared with the expected river flow of approximately 113 m^3/s (4000 ft^3/s). The measured rise in water temperature was less than 0.56°C (1°F). The warm water input melted the existing ice so that ice floes passed unhindered during the natural breakup period and flooding was averted (Figure B-2).

c. This $450,000 system worked successfully for 2 consecutive years. There were no reported negative environmental impacts.

B-2. Hardwick, Vermont—Improved Natural Storage, Ice Retention, Mechanical Removal

a. Relatively frequent breakup ice jams have caused serious damage in this small Vermont town. A combination of techniques is used to reduce flooding impacts.

b. To slow the movement of broken ice, two booms were constructed (Figure B-3). The vertically oriented tire booms, which are suspended from shore, collect broken ice during breakup, some of which is stored on the overbanks. The booms delay the downstream passage of ice while ice removal is performed in town. Since the winter of 1983–84, these booms have been placed upstream from town annually. Although the booms occasionally fail, they do provide ice retention.

c. An ice storage area downstream of the town accommodates some of the ice that jams and thereby provides added protection. In addition, when local officials first begin to notice serious ice jams developing, the town road crew mechanically breaks up and removes the ice to keep the river open.

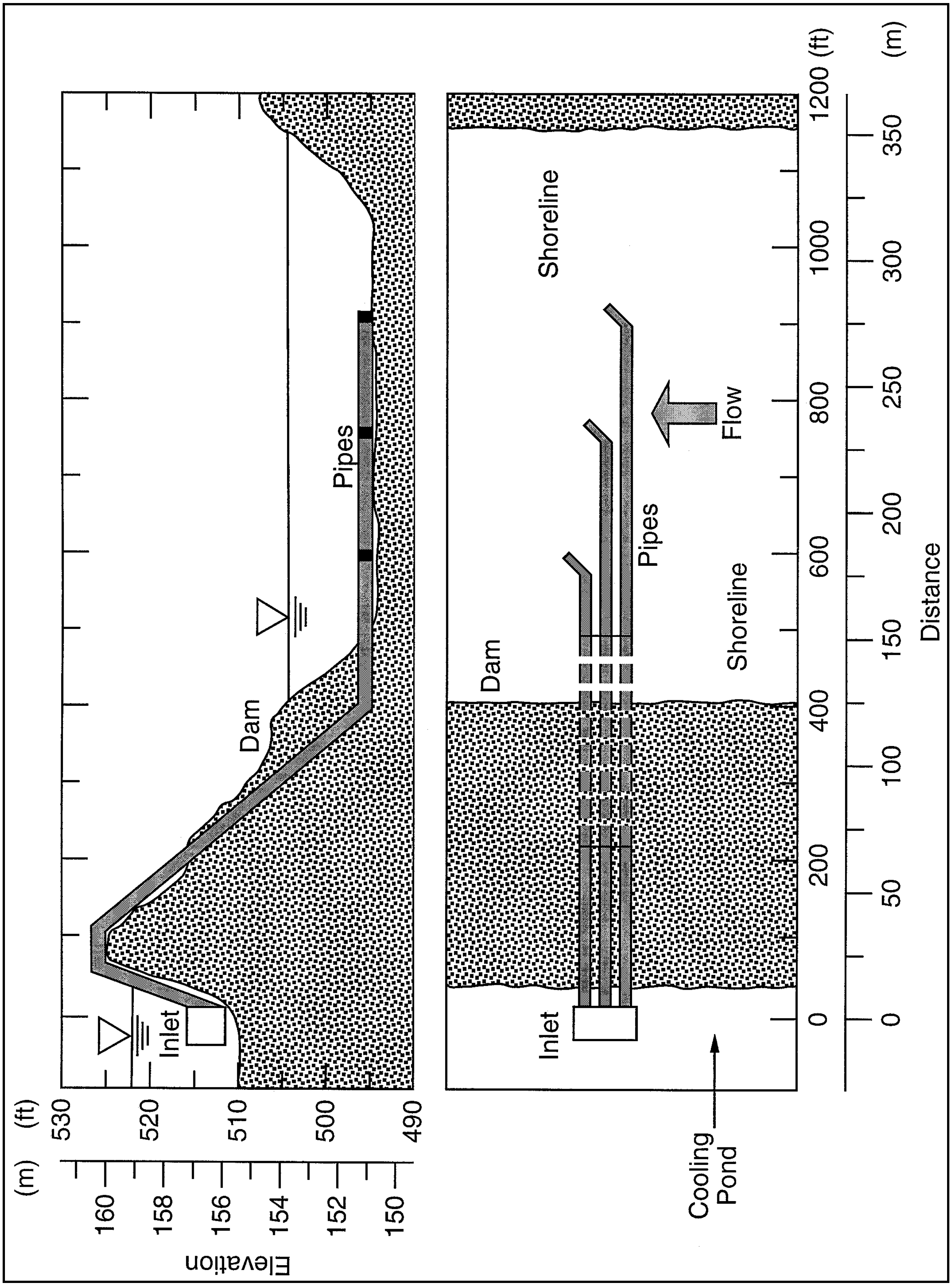

Figure B-1. Schematic of siphon system, Kankakee River, Illinois

Figure B-2. Map of meltout, Kankakee River, Illinois

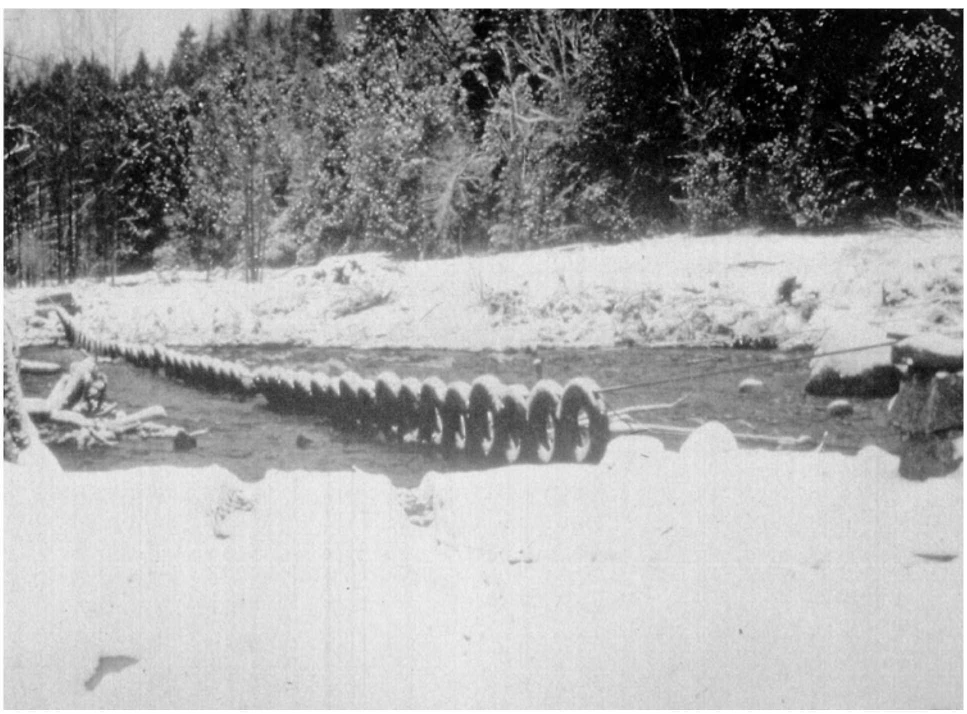

Figure B-3. Tire boom at Hardwick, Vermont

B-3. Oil City, Pennsylvania—Floating Ice Boom, Revised Operational Procedures, Ice Control Dam

a. Oil City is located in northwestern Pennsylvania. The city suffered chronic ice jam flooding from the mid-1880s to the mid-1980s. In February 1982, ice jam flooding caused more than $4 million in damages in downtown Oil City.

b. Research indicates that the ice jam flooding was caused in part by a massive deposit of frazil ice naturally occurring in a long, deep pool in the Allegheny River downstream of Oil City and extending upstream past the confluence with Oil Creek. Large quantities of frazil generated in the creek were also deposited in the river and backwater at the mouth of the creek. The ice on Oil Creek typically broke up and moved downstream before the ice cover on the Allegheny River. The tributary ice ran unimpeded to the river until it met the stable ice at the confluence with the Allegheny River and formed an ice jam.

c. An environmentally and economically beneficial floating structure (Figure B-4) was designed and installed upstream of the city on the Allegheny River to quickly form a stable ice cover to suppress further frazil generation and minimize excessive deposition in the trouble area. Discharge at an upstream dam was decreased during freezeup to allow the rapid formation of a stable ice cover at the boom. The floating boom was installed during the 1982–83 winter at a cost of $900,000. Since its installation, the boom has been fully effective and the river has remained relatively ice-free downstream from the boom in spite of extremely cold winters (Deck 1984).

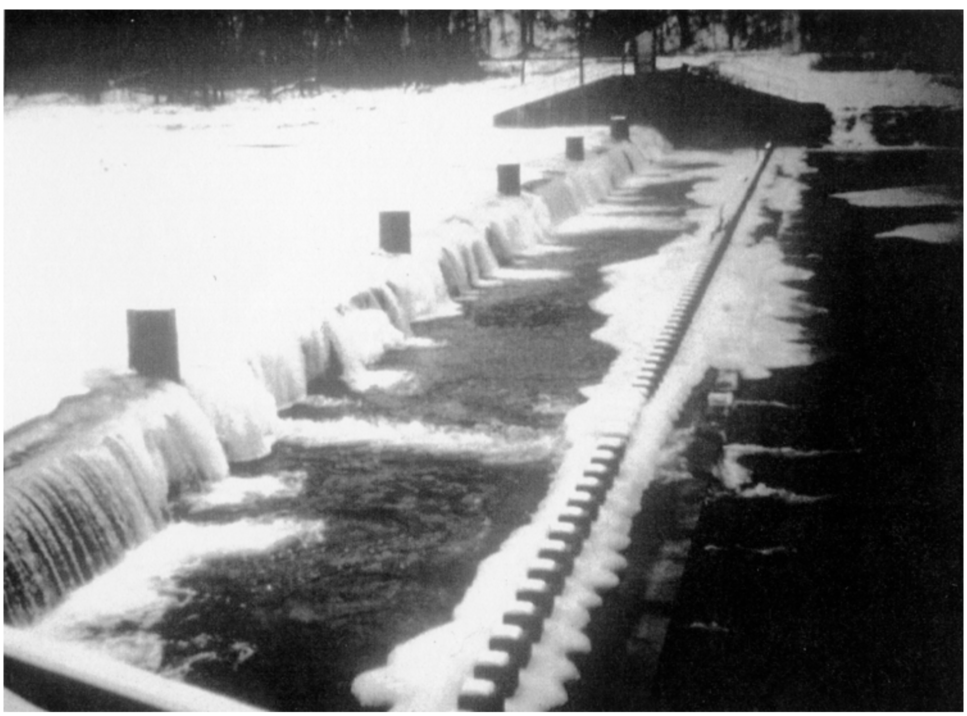

Figure B-4. Oil Creek ice-control structure, Oil City, Pennsylvania

d. A permanent ice-control structure was also constructed on Oil Creek by the Pittsburgh District of the Corps of Engineers in 1989. The structure is 1.5 meters (5 feet high), 107 meters (351 feet) long, and includes a 13.7-meter-wide (45-foot-wide) leaf gate, which allows for sediment and fish passage, as well as recreational use by canoeists and fishermen. Two low-flow pipes also provide fish passage. Levees were constructed on both upstream banks to contain the Standard Project Flood. The project cost was

$2.2 million (Wuebben and Gagnon 1995). No damaging ice jam has occurred in Oil City since the Allegheny River ice boom and Oil Creek ice control structure were put into use.

B-4. Lancaster, New Hampshire—Weir, Ice Retention, Storage

a. Lancaster, New Hampshire, experienced ice jams every year because of the breakup of the ice cover on the Israel River. Broken ice passage is impeded by a natural frazil deposit that forms at the change in slope, which occurs at the upper end of the backwater formed by the confluence with the Connecticut River. Few ice jams were reported prior to 1936, probably because four dams then in existence decreased frazil production, provided frazil ice storage, decreased the downstream transport of frazil ice, and delayed the downstream passage of broken ice. The dams have been removed since that time.

b. The Corps' New England Division (now New England District) and CRREL designed and built an ice control project to reduce the production and transport of frazil ice and decrease the volume of ice available to ice jams downstream. Environmental and financial constraints limited the scope of the project, which ideally would have provided the same protection as the four dams. The project consists of two parts: 1) a submarine net to capture surface ice, and 2) a 36.6-meter-long by 2.7-meter-high (120-foot-long) by 9-foot-high permanent weir located several miles downstream (Figure B-5). The submarine net is a form of suspended ice retention structure that allows water to flow through but captures floating ice pieces, which are then stored in overbank floodplains.

c. The ice control weir includes four 1.2-meter-wide by 2.4-meter-deep (4-foot-wide by 8-foot-deep) sluiceways for fish passage. During the winter, stop logs or metal bar racks are placed in the sluiceways to develop an ice retention pool. The pool forms an ice cover, and frazil ice generated upstream deposits beneath the ice cover. After the ice cover has formed, two of the gates are opened, allowing the pool level to drop. This creates additional water storage in the pool area, provides additional discharge capacity through the weir, and slightly delays the breakup and movement of ice through the pool as well. The project, which cost $300,000 was completed in 1982. Although costs constrained the size of the project to less than ideal, no major flooding has occurred since this relatively inexpensive, innovative project was constructed (Axelson 1991).

B-5. Idaho Falls, Idaho—Land Acquisition

In 1982, two hydroelectric dams were removed and rebuilt on the Snake River near Idaho Falls, Idaho. Freezeup ice jam floods on the Snake River affected Bear Island homeowners during the winters of 1982–83 and 1984–85. Ice jam floods also threatened two houses on the west bank of the river. The homeowners associated their flooding problems with the rebuilt dams located 9.7 kilometers (6 miles) downstream. As a result, they requested help from the city of Idaho Falls, the Federal Energy Regulatory Commission, and elected officials. Field data collection and hydraulic analyses indicated that ice jams were caused by frazil produced in turbulent open-water sections of the Snake River. The results showed that the changes in reservoir levels and the dams had no direct effect on ice jam flood levels in one area, although two properties were affected by changes in reservoir levels. Based on CRREL's recommendations, the City of Idaho Falls decided to purchase the two properties affected by the Upper Power Project (Zufelt et al. 1990).

a. Installing racks in sluiceways

Figure B-5. Lancaster, New Hampshire, weir

B-6. Platte River, Nebraska—Dusting

a. In February 1978, disastrous ice jam flooding took place on the Platte River in Nebraska, causing millions of dollars in damages. Record cold in January 1979 produced both extremely thick ice on the Platte River and its tributaries and a consequent threat of similar ice jams during spring breakup. Ice dusting, approximately 3 weeks before breakup, was recommended for alleviating ice jam floods.

b. Ice accumulated behind structure in early spring

Figure B-5. (Concluded)

b. The Nebraska Civil Defense Agency decided to try dusting selected areas with technical assistance from the Corps. The Corps assisted with advance preparation for the ice dusting operation, during the actual dusting procedures to ensure a proper application rate on the test areas, and during subsequent measurements to evaluate the effectiveness of the program. Dusting was performed using coal ash and slag from a local power plant.

c. Two periods of breakup occurred in March 1979. Because the dusted ice had already started to deteriorate, the jams were minor, even following heavy rains. The ice and water flowed smoothly down the channel with no flood damages (U.S. Army 1979).

d. Similar dusting operations were repeated in March 1994, prompted by severe ice jam flooding in the spring of 1993 that threatened the water wells supplying the city of Lincoln, Nebraska (U.S. Army 1994).

B-7. Allagash, Maine—Floodproofing, Relocation

a. Rainfall and 5 to 6 days of mild weather resulted in breakup ice jams and severe flooding on the St. John, Little Black, Allagash, and Aroostook rivers of northern Maine in April 1991. In Allagash, two bridges and 11 homes on the St. John River were destroyed; 22 other homes suffered damages. A 30-meter (1000-foot) section of a state highway was washed away. Ice jam flooding also caused evacuations and damage to 16 homes in neighboring towns. Damages totaled more than $14 million, mostly for rebuilding bridges, roads, and other public works (Federal Emergency Management Agency 1991).

b. Raising the affected buildings was considered. However, it was determined that elevation of the ground floor of homes to meet the requirements of the National Flood Insurance Program and local floodplain regulations might not provide adequate protection from future ice jams. In the town of Dickey, several residents indicated a willingness to relocate outside the floodplain. The following permanent settlement changes were made:

Three new homes were built at higher elevations on the original lots, and one home was repaired and moved to higher ground on the same lot.

Two new homes were constructed on new sites outside the floodplain, three homes were repaired and were moved to higher ground outside the floodplain, and two destroyed homes were replaced with mobile homes on higher sites.

Thirteen wells or septic systems were replaced with mitigation measures, meaning they were floodproofed or moved to higher ground.

B-8. References

a. Required publications.
None.

b. Related publications.

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